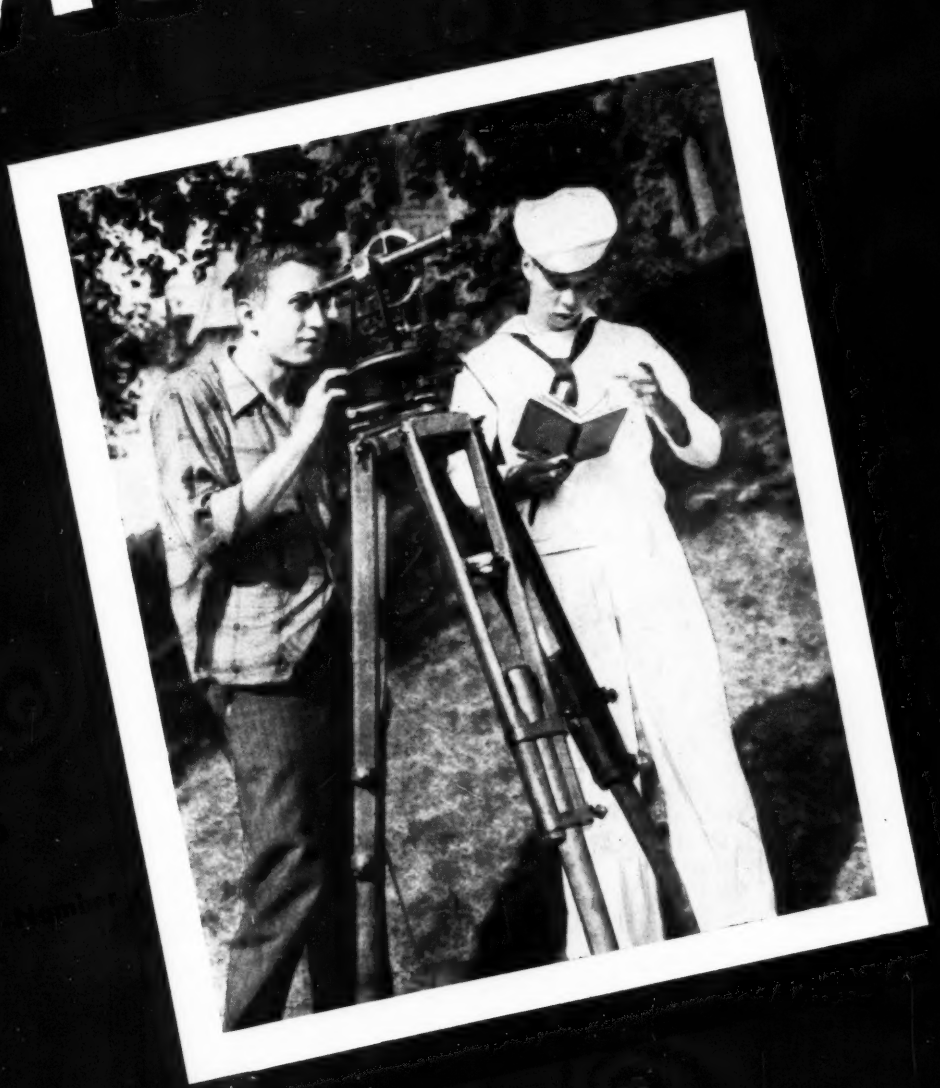
THE CORNELL ENGINEER



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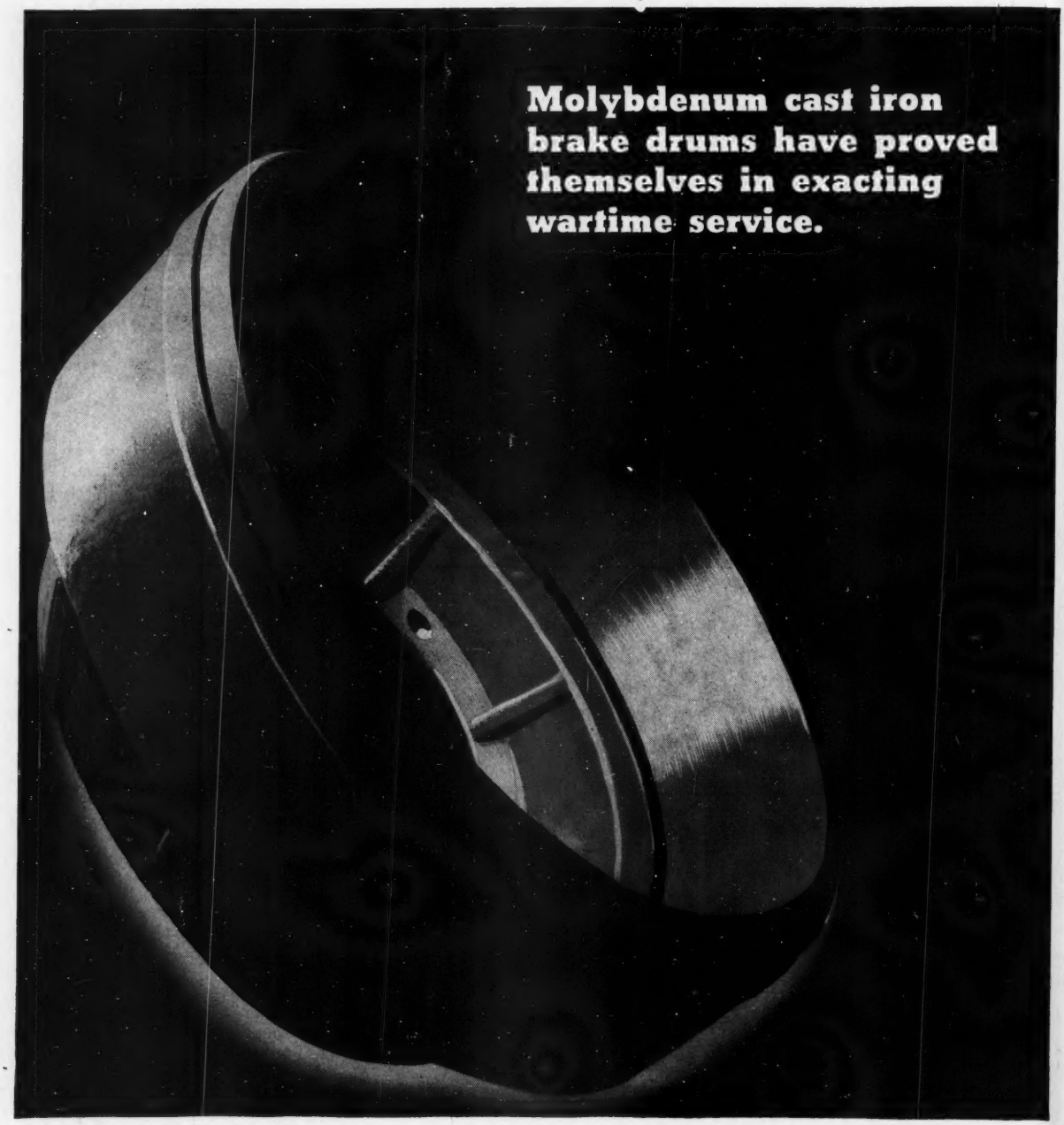

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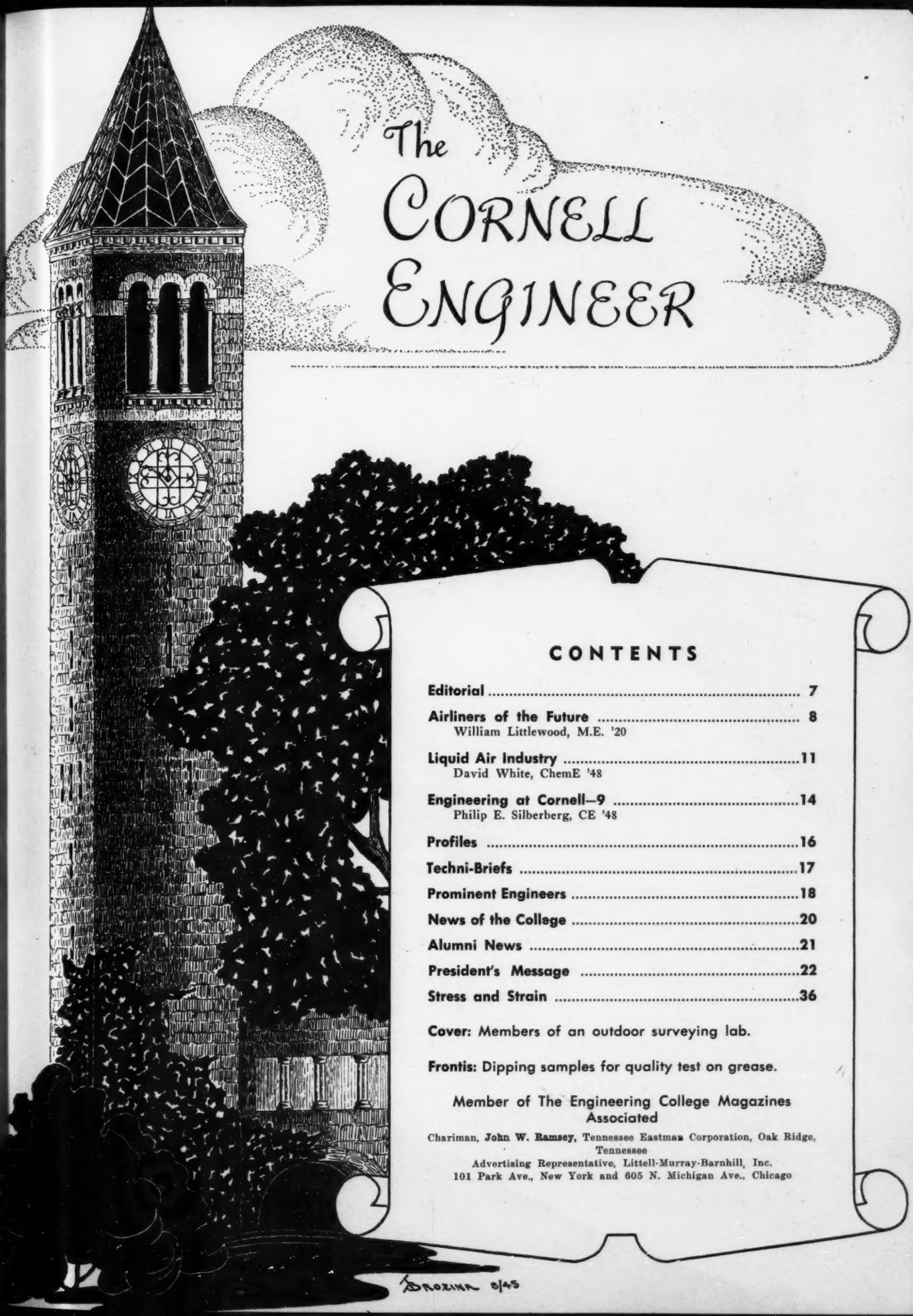

The CORNELL ENGINEER

CONTENTS

Editorial 7

Airliners of the Future 8
William Littlewood, M.E. '20

Liquid Air Industry 11
David White, ChemE '48

Engineering at Cornell—9 14
Philip E. Silberberg, CE '48

Profiles 16

Techni-Briefs 17

Prominent Engineers 18

News of the College 20

Alumni News 21

President's Message 22

Stress and Strain 36

Cover: Members of an outdoor surveying lab.

Frontis: Dipping samples for quality test on grease.

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Editorial . . .

Reconversion

THE general scholastic average for engineering students at Cornell has reached an all time low during the last few terms. The attitude toward many courses has been reduced to the level of, "if I get a sixty I'll be satisfied." Numerous professors felt justified in merely presenting their material, with no personality or apparent interest in getting the subject across to the student. During the war these two conditions were excused and neglected for some or all of the following reasons: heavy schedules, fatigue from studying too much, Navy routine to be followed, too many students in each class, and students being forced to take courses they were not interested in. No one seemed to recognize this deplorable situation, and, if they did, they were "too busy to bother with it now."

The war has ended and Cornell has started its first peacetime term in four years. Returning veterans are willing and eager to continue work at the high standards enjoyed in the pre-war days. New students have entered ready to live up to the well-known Cornell reputation. Is the Engineering School going to snap out of its war-time habits and re-establish its better pre-war level?

This can be done only if every student and professor awakes to the fact that Cornell has slid from its high position. Other engineering schools are probably going through the same experience. But it is the outstanding school that can cast aside these difficulties and be one of the first to reconvert. Cornell can and should be the leader in this situation.

One step in the right direction is to place the scholastic year on a two-term basis. This will afford easier and better scheduling processes, and give time for much needed vacations during the term. The length of each term could even be made slightly longer to include valuable material dropped from courses because of the shortness of time.

Another important step is to re-establish specialized courses which have been dropped because of faculty shortages. This might be a partial explanation as to why grades have been so low. Students have been forced to take subjects in which their interest has been a negative quantity. This situation has led to unnecessary friction between faculty and students. Merely passing prelims has been, in many instances, the motive for learning rather than a desire for a real understanding of the subject matter. This type of learning does not produce outstanding engineers, and only brings about an exceedingly dull college experience. This was even reflected in the subjects in which the student was interested and brought about an indifferent attitude of the teacher toward his class.

The college as a whole should turn over a new leaf and roll up its sleeves, ready to start a new and important phase in this post-war period. Thinking should be stimulated along these lines so that the time of reconversion will be as short as possible rather than a long, drawn-out, inadequate readjustment.

R. E. G.

AIRLINERS OF THE FUTURE

By WILLIAM LITTLEWOOD, M.E. '20

Vice-President of American Airlines

THERE is a popular belief that the war has stimulated the advance of aviation almost overnight to a condition where all technical problems are solved. Nothing could be further from the truth. The war, with its urgent requirements and utter disregard of cost, has demanded and achieved a tremendous acceleration in the fields of aviation research and production. We are, however, dealing with complex technical developments in which the element of time cannot be disregarded.

The following will be confined to the first five-year period and particularly to those transport aircraft of the early postwar period which are already in process of development from military transport types, which were themselves adapted from airplanes developed for commercial use, or are new designs being actively discussed between operators and manufacturers, and have progressed to the preliminary design and mockup stages. These airplanes, which may be available for transport use from one to three years from now, and which thereafter must obviously be planned to serve from five to ten years in airline operation, are all of quite conventional arrangement.

Before the war, most conventional domestic air transportation was performed with one type of airplane, commonly used as a 21-passenger day plane but with some application, much appreciated for long range operation, as a 14-passenger sleeper. There were also in domestic operation a few somewhat smaller, faster airplanes of a definitely lower standard of passenger comfort. These prewar transports were used for a tremendous variety of operations at operating ranges from occasional 25 mile intervals to almost 1,000 miles. They were not well suited to the short ranges where they did not have sufficient seating capacity to carry the possible and most efficient loads, nor to the long ranges where the fuel requirements cut into the payload, making it possible to carry only a percentage of the nominal passenger capacity. It becomes necessary, therefore, to analyze the utilization of aircraft in a particular system, to decide whether or not there is enough need for a particular load and type of service at a particular range to justify the adoption of an airplane model specifically designed for maximum efficiency in that type of operation. If there is not a substantial amount of such specific operation, it is far better to use for this and other services an airplane designed to cover a broader latitude with good but obviously less than optimum efficiency.

One significant element of this range picture is the basic fact that the optimum size of aircraft increases with range. This is, fortunately, consistent with the travel requirements since greater frequency of schedule with smaller units is a natural characteristic of short range travel, which is undertaken without elaborate preparation; whereas less frequent departures with larger units having substantial elements of greater comfort, are natural accompaniments of long range operation. There is, however, grave economic uncertainty in the use of too large aircraft units. The economic advantages of size at any given range, increase much more slowly as sizes are enlarged beyond an essential minimum. On the other hand, indicated first costs increase very rapidly with size, out of all proportion to capacity on a basis of a uniform standard of passenger comfort, probably due to the increase of potential market and the disproportionately increased development costs.

THE AUTHOR

William Littlewood, present Vice-President of America Airlines, Inc., in charge of Engineering, graduated from Cornell in 1920. After becoming Experimental and Test Engineer for Niles-Bement-Pond Co., he joined Ingersoll-Rand Co. where he was made Chief Inspector. Later he was appointed General Manager of Fairchild Engine Co. After being transferred to Aviation Corporation and assigned special engineering projects, Mr. Littlewood became Maintenance Engineer of American Airlines. Mr. Littlewood became Vice-President of the company in 1937, after being Chief Engineer for a period. In 1935, he was awarded the Wright Bros. Medal for outstanding contribution to aviation.

—Photo by Bachrach

Mr. Littlewood

Economic penalties, however, of too small aircraft, which come under consideration for the shorter range operations, are so great as to limit the probable development of that type of operation except for those special cases in which competing transportation is highly unsatisfactory and geographical considerations made the distance element much less significant than the time factor.

We must never lose sight of the fact that the great attraction of, and basic justification for, aviation is time saving, usually attained by speed. People will fly if it is safe, comfortable, and convenient, providing it is fast and the cost bears some relationship to the speed advantage. Any time aviation can achieve added speed it will draw that many more customers, continuously creating a new travel market of people who will go places because they can do it in the time available. Obviously, any speed which air transport design can achieve by improved aerodynamic cleanness should be obtained, and the absence of refinements to achieve such a goal is almost inexcusable in the light of modern knowledge and design practices. The basic trend toward operations at high altitudes to achieve economical speed advantages in the air of lower density is obviously something of which the operator should take full advantage, but this ability must be designed into the transport airplane. Altitude availability is also of inestimable value in operations to take full advantage of meterological conditions both with respect to wind and weather.

Power and Wing Loading

The most significant factor in the rapidly advancing speed characteristic of modern transport aircraft is, however, the relationship between power and wing loadings. The availability of large power plants, substantial aerodynamic improvements, and the growing realization that so many factors of operating cost decrease with speed as compared with the few which increase with it, make it very desirable to err on the side of too much power in transport aircraft design.

Short range operation will be conducted in the low altitudes which will tend to cause bumpy, uncomfortable flights under many meterological conditions. The only practical approaches to smoothing out these short flights are using as large an airplane as possible in what is a naturally small airplane activity to achieve the advantage of high inertia and, much more important, employing relatively high wing loadings to provide a smoother ride in the bumpy air. If we increase the wing loadings, we must inevitably have larger engines to achieve the desired performance and we automatically achieve high speed.

I think it is safe to say that we will have both twin engine and four engine aircraft with a growing trend toward the more common use of four engines because of the increased range and weather operations contemplated with units of increased size. Certainly, no thought is being given to the commercial use of single engine aircraft other than for private flying and possibly some limited cargo transport ventures. I know of no serious contemplation of three engine aircraft, which are still beset by the same objections as in the past, although on a theoretical basis they have always appeared to have some advantages. The use of more than four engines, is in my opinion, contemplated only in consideration of the unavailability of engine units of adequate h.p. to accommodate the total requirement with four such units. The added complexity of such installations is highly undesirable and there are no adequate compensating advantages. All metal construction hardly requires comment in passing other than to note the trend toward the use of aluminum alloys of substantially higher physical properties.

In my opinion, the great majority of passenger transport aircraft will be of the basically low wing type which in the largest units may well become a midwing arrangement retaining all the safety characteristics of the low wing disposition. For cargo operation, the obvious ground handling advantages and the lack of passenger safety requirements, make the high wing airplane preferable. It is my opinion

American Airlines DC-4 Flagship in flight.

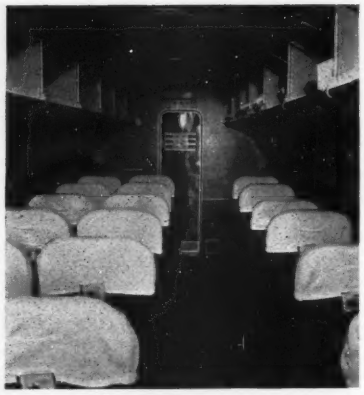
Bi-motored Airliner

that fully satisfactory crew safety can be achieved in such high wing airplanes.

One highly desirable and, in long range, high altitude operation, essential accompaniment of modern transport design is fuselage pressurization, including the passenger, cockpit, and cargo storage compartments. In addition to promoting passenger comfort and health by guarding against distressing pressure changes with changes of altitude and providing the needed low altitude oxygen at high altitude, cabin pressurization also promotes efficiency of operation by permitting increased rates of ascent and descent, thus giving longer time of operation at the more efficient higher altitudes. It also increases the usable altitude range of the airplane, assuming that the pressurization provisions are accompanied by suitable altitude engine power characteristics, so that an optimum selection of operating altitude is possible, consistent with wind and weather conditions. It appears that the time will come when cabin pressurization will be available in all transport aircraft.

Ice Protection

We can look forward to substantial improvements in ice protection in the refined early postwar transport airplane. The fact that the airplane is entirely immersed in the weather condition makes the action of that weather condition on the vehicle a positively determinable effect which can be fully provided against. This cannot be true of any surface vehicle where the inter-relation of the vehicle and the weather condition is compounded by the presence of a third element, which may be the sea or the land. I know of no proposals by which boats in winter weather can be kept free of ice or can navigate frozen waters. I know of no proposals by which trains or automobiles can negotiate their respective highways without embarrassment in the face of many types of weather and flood conditions. The airplane, however, having a definite and determinable relation to the medium in which it operates, can be fully protected against external conditions with the possible exception of extreme turbulence. Even this problem is minimized by the airplane's freedom of action permitting it to select without serious time penalty, courses to avoid such severe storm conditions, either on the basis of altitude or direction.



DC-3 Interior

The primary detrimental effects of ice formations are not usually weight accumulations but are those effects which interfere with the development of engine power or the development of wing and airfoil lift delivery of propeller thrust or the reactions or the operation of control surfaces. Some of these can be guarded against with full adequacy by design detail. Among these are induction system impact icing and control surface icing. Radio antenna icing, it is hoped, will be fully protected against by the eventual elimination of external antennae. The remaining icing problems will be adequately protected against by both design refinement and the application of adequate heat. Inflatable rubber boots and alcohol have been reasonably effective for wing and propeller applications, respectively, but it is felt that these problems may be even better solved by the use of heat derived from the engine exhaust or auxiliary heater units. Alcohol has also been a valuable emergency protection against induction system evaporative ice, but it is hoped that design detail will completely solve that problem.

One of the great technical developments accelerated by the urgency of the war has been the refinement and application of radio devices to solve the air navigation, aiming, and identification problems. In its radar refinement, the development of positive distance and direction indications has made available, a tool which when properly applied will go a long way to solving the airway and airport traffic control, instrument approach, and instrument landing problems. We have every reason to look forward hopefully to an almost complete solution of the instrument flying and landing problems within the next five years, partly with equipment to be carried aboard the airplanes but also with equipment giving full information and supplementary control possibilities from the ground.

The general adoption of tricycle landing gears, in addition to providing excellent directional ground stability and improved landing attiude characteristics in contemplation of the early achievement of instrument landings, has introduced an additional problem of braking because of the reduction of aerodynamic drag. The necessity for multiple brakes therefore becomes more apparent, and in addition, on all four-engine aircraft, the already demonstrated desirability of reversing thrust propellers on at least two engines.

Utilization of Exhaust

One of the most important efficiency developments to be realized to an increasing degree during the transition period in the development and evolution of power plants of radically different type, is the augmentation of propeller thrust by the use of all possible of the waste exhaust energy. Insofar as this application can be made it is, of course, the most efficient use to make of the continually wasted exhaust energy. Other wasted heat applications, such as providing a source for heat deicing or providing heat for cabin comfort, are purely occasional uses. The continuous application of all possible of this energy to develop thrust is, however, and efficiency advantage which is present at all times. The simplest and most direct application is the use of the jet principle, using the accelerated exhaust gases as the thrust developing means. Early efforts in this direction have been highly successful with respect to the efficiency produced but have in-

(*Continued on page* 28)

LIQUID AIR INDUSTRY

By DAVID WHITE, ChemE '48

MAN has always sought new ways to protect himself from the cold grasp of sub-zero weather. Clothes and shelter are necessities partly because of low temperatures. But scientific zeal has kept us from progressing in only one direction. The desire to produce lower and lower temperatures and the urge to liquefy every known gas led to the field of low temperature research. As a result, air, that material which we could feel but not see, was finally liquefied and reduced to a form which could be readily seen. Liquid air is not now just a novelty but is the product of an industry of national importance.

History

Probably the first person who accomplished anything great in the liquefaction of gases was Faraday, aided by Sir Humphrey Davy. Before Faraday's time, it was held that gases were different from vapors, such as steam, and that gases could never be condensed to the liquid state. Faraday succeeded, however, in the early part of the nineteenth century, in liquefying several gases, including chlorine. Later, carbon dioxide and other gases were liquefied. Still, certain gases such as air (which is approximately 21% oxygen and 79% nitrogen) and hydrogen refused to be liquefied under the conditions by which other gases had been liquefied. These gases were assumed noncondensible and given the name "permanent" gases.

In 1863, Andrews investigated the liquefaction of carbon dioxide but failed in liquefying the permanent gases at high pressures and at temperatures down to —110 degrees C. However, he brought out the point that for every gas there is a "critical" temperature above which it is impossible to liquefy the gas at any pressure. Scientists then realized that the problem in the liquefaction of the permanent gases was one of producing temperatures below the critical temperatures of the gases—the critical temperature of nitrogen being —147 degrees C., and that of oxygen, —119 degrees C. Finally Louis Cailletet and Raoul Pictet, working separately, succeeded in obtaining a mist of liquid oxygen when oxygen, compressed and cooled, was allowed to escape through a small valve. In 1883, two Polish chemists, using liquid ethylene as an intermediate cooling agent, obtained enough liquid oxygen for the determination of some of its physical properties. However, methods for the large scale production of liquid air were not developed until about ten years later by Linde in Germany and W. Hampson in England.

Most of the processes in use today for the production of liquid air are based on the following principle known as the Joule-Thomson effect. It is found that most gases under high pressures have a smaller volume than that calculated by the pressure-volume relationship for gases. This is due to the fact that gas molecules exert a greater force of attraction on each other when they are pressed closed together. Therefore, when a compressed gas is allowed to expand, work is done in overcoming these molecular forces. Since the work done comes from heat sources, it follows that if

Prof. Grantham, of the Physics Department, checking the pressure gauges of the compressor used with the liquid air machine located in the basement of Rockefeller Hall. This machine, installed in 1930, can produce six liters of liquid air per hours.

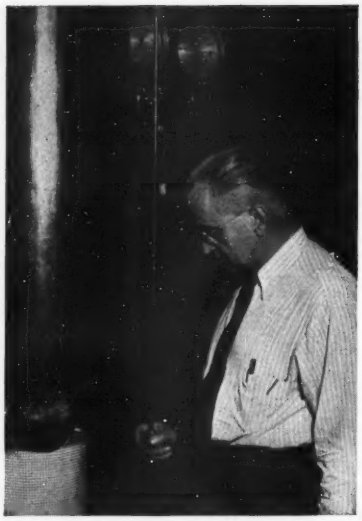
the expansion is rapid, the heat absorbed will be from the gas itself—the gas being cooled in the process. This principle was investigated by Joule and Thomson in 1854. The "Regenerative Method," also used in most liquefaction machines, involves the use of a device which enables cooled, expanded gas which has not liquefied in the expansion process to cool the incoming compressed gas. Such a device is often called a "heat-exchanger." The expanded gas, after passing through the heat-exchanger, is only three or four degrees above room temperature. Since the heat that warms this expanded gas comes from the entering compressed gas, the method is very efficient.

For the success of any system used for the manufacture of liquid air, the gas must be purified and then compressed to the initial pressure before liquefaction. Air is usually cleaned by passing it through a container of a drying agent such as caustic soda. In this way, water and carbon dioxide, which would clog up the apparatus if left in the air, are removed. Compression is obtained by compressors which give pressures from forty to two-hundred atmospheres. Precooling by refrigeration generally accompanies the preliminary processes to increase the efficiency of the process.

Processes of Manufacture

There are three main processes in use today for the industrial manufacture of liquid air: (1) the Linde process, developed about 1895; (2) the Hampson process, devised at about the same time; (3) and the Claude system, developed in 1902. A fourth method, suggested by Pictet, and often called the cascade system, is not in general use today. It involves the use of several gases; a gas having a relatively high boiling point is liquefied by cooling and compression, and then boiled under reduced pressure to liquefy a gas of slightly lower boiling point. This process is repeated until a gas is liquefied that may be used to cool air to the liquefaction point.

The Linde apparatus depends on the Joule-Thomson effect and also uses the heat-exchanger. Precooled air at a pressure of about 150 atmospheres is introduced into the liquefying column—the inner tube of two concentric tubes surrounded by an insulating medium. Here it is cooled by the expanded cool gas in the outer tube. At the bottom of the column it is allowed to expand through a very small opening, controlled by a valve, to a pressure of about 40 atmospheres. This rapid expansion cools the gas which then returns to the compressor through the outer pipe, countercurrent to the incoming gas. After a time the air expanding through the valve is cooled below the liquefaction temperature and liquid air is formed. It collects at the bottom of the apparatus and may be tapped off. Since the air which is not liquefied is sent back to the compressor to go through the apparatus again, much of the work of compression is saved, because the work done in compressing the air from 40 to 150 atmospheres is much less than if the air had to be compressed from one to 150 atmospheres. The cooling loss, however, from only expanding the gas to 40 atmospheres instead of to one atmosphere is very small. The Linde process forms the basis of the majority of industrial plants manufacturing liquid air today.



Liquid air being drawn from the bottom of the liquefying column.

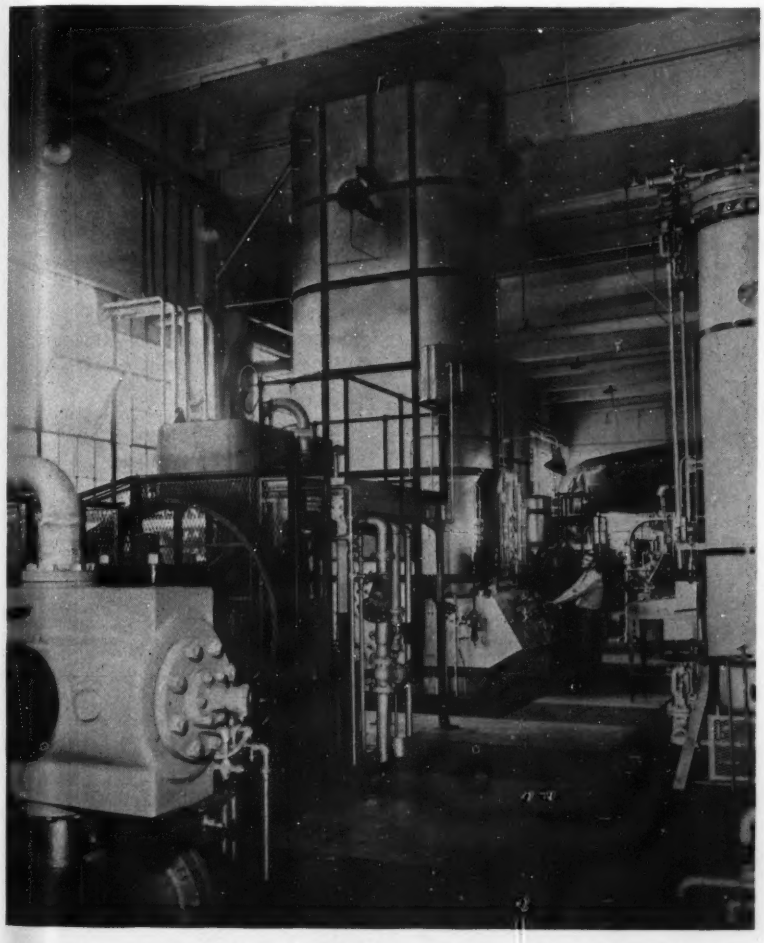
The Hampson process is very similar to the Linde process in both principle and design, the only main difference being that the gas is expanded to normal atmospheric pressure instead of to 40 atmospheres. Though the efficiency of the process is not so great, the apparatus is much simpler and is useful where small quantities of liquid air are wanted for laboratory use and experimental work. A machine of this type produces about one liter of liquid air per hour.

The Claude system (sometimes called the Claude-Heylandt system) allows cooled compressed air to do external work by running it through a turbine or expansion engine. Thus the work done is greater, and if no heat comes from the outside, the cooling effect is greater. The efficiency is increased, but the energy received from the turbine is usually wasted and not connected to the compressor. As used today, the system is usually combined with a machine of the Hampson type. That is, the cooled air from the expansion engine is used to cool compressed air which expands through a small orifice and liquefies by the Joule-Thomson effect. Claude also found that liquid air itself could be used as a lubricant in the engine, ordinary lubricating oils being of no use at such temperatures.

Separation of Cases

Since by far the greatest use of liquid air is for the production of oxygen and nitrogen, there have been several processes developed for the separation of these two gases from liquid air. All are based on the difference of boiling points of liquid oxygen and nitrogen—that of oxygen being —183° C. and that of nitrogen, —196° C. Linde again was one of the pioneers in this field and he succeeded in separating oxygen from air on an industrial scale in 1901. He let liquid air slowly drop down a vertical cylinder filled with glass balls to a tank where it was partially evaporated by heat. The air vapor passing upward underwent a heat exchange with the descending liquid air. As a result almost pure nitrogen gas came out the top, and the liquid at the bottom was 96% to 98% oxygen. This process, however, is inefficient and few plants use it. The system in greatest use for the production of nitrogen and oxygen from air is one developed by Claude. Air, cooled by expansion and at four atmospheres pressure, is mixed with

liquid air from a liquefier so that a small amount of the liquid is in contact with a large amount of the gas. Since these are the conditions prevailing when the liquefaction of air first begins, that is, when the oxygen first starts to liquefy, the gas is enriched with nitrogen, and the oxygen is "washed" out of the vapor. The resulting liquid contains about 40% oxygen and the gas, now poor in oxygen, passes through tubes surrounded by almost pure liquid oxygen from a later part of the process. Here it is condensed. Both liquids are then transferred to a fractionating column, operating at atmospheric pressure, where the nitrogen-rich liquid is introduced at the top and the liquid containing 40% oxygen is introduced at a point where its composition is the same as that of the descending liquid. The descending liquid is scrubbed by the gases produced from the evaporation of almost pure liquid oxygen, which surrounds the tubes of nitrogen-rich gas from before. The heat from the condensation of this nitrogen-rich gas is used to evaporate the above-mentioned liquid oxygen. As a result, 99.5% pure liquid oxygen is obtained and nitrogen gas passes out the top of the fractionating column. Plants using this process produce about 4000 cubic feet of gaseous oxygen per hour.



High-purity oxygen for metal working comes from this column in a modern plant where oxygen, nitrogen, argon and rare gases are extracted from the air.

Physical Prop

The properties of liquid air make it a very interesting and useful substance. When produced, it is usually opalescent at first, probably from solid carbon dioxide in suspension. These particles may be separated, leaving a pale blue liquid about as heavy as water. When the substance is left open to the air in a container, it boils vigorously. The nitrogen evaporates faster than the oxygen leaving a liquid richer in oxygen. Solid air may even be produced by surrounding a container of liquid air with liquid oxygen and forcing evaporation of the liquid oxygen by reducing the pressure. The heat for the evaporation comes from the liquid air, and a clear, transparent solid results.

Many substances react strangely under the influence of the low temperatures produced by liquid air. Rubber becomes brittle when immersed in liquid air, and a rubber ball, at this temperature, shatters into pieces when bounced on the floor. Milk gives off light and an egg becomes a blue globe. Photographic films are no longer sensitive to light; the electrical resistance of metals becomes much less. When bacteria or seeds are kept at the temperature of liquid air they are inactive, but when returned to normal they seem to be unaffected. Liquid air is a perfect insulator and also is a comparatively inert substance. Sodium and phosphorus do not react when immersed in it.

When liquid air is to be kept for some time, it is usually put in a Dewar flask. This consists of a double-walled open glass container with the space between the walls a vacuum and the walls silvered. The vacuum cuts down the entrance of heat by conduction or convection, and the silvered sides prevent the radiation of heat into the vessel. In this way, heat may be kept from entering the vessel in any appreciable quantity, and liquid air may be kept for use in low temperature research and similar fields.

Uses of Liquid Air

Liquid air is often of important use in experimental laboratories where it may be used to condense gases for separation or analysis. For example, liquid air is used in the determination of the per cent carbon in iron. The carbon is oxidized to carbon dioxide which may be solidified and separated. Other applications involving low temperatures make liquid air a useful substance. It is in wide use for the preparation of vacuums. This is done by using charcoal cooled ex-

(*Continued on page* 34)

Engineering At Cornell

9. Surveying Laboratories

By PHILIP ERWIN SILBERBERG, CE '48

PROBABLY the closest contact that Cornellians who are not Civil Engineering students have to those who are is via the surveying courses. Since the advent of the "emergency period," all surveying given by the school has been confined to the campus. Usually, during warm weather, every bit of green on the quadrangle and library slope is dotted with transits, levels, tapes, rods, and embryo Civil Engineers.

It is most probable that these men are in no wise actually surveying any part of the campus, but are getting practical knowledge of the instruments by using them on a chance piece of ground. Stakes are driven, lines are run, and angles are read; but, for all that was done that would benefit an actual survey of the Cornell campus, the hard working CE's might just as well run their lines in Siberia or Squeedunk, Kansas.

Problems Different

To the lay casual onlooker, it seems that the surveyors are doing the same thing each afternoon or morning as the case may be. In a way they are, as to reading angles and rods, and measuring distances. But each problem is different in some way, making it dissimilar to the surveyors though similar to the watchers. All that elementary surveying happens to be is the reading of these angles, the running of these lines, etc. It is the end result that is different, as the problem may be to locate buildings, map terrain, run a curve, find elevation or a host of different things. Besides getting a practical knowledge of surveying, this furnishes an insight into other branches of Civil Engineering.

Taken for itself, surveying is considered rather an elementary subject and one finds very few going into this field as a career. At the time of the early Cornell Civil Engineering School, classes of the graduates would immediately go into surveying as a means of livelihood. That was the period of great expansion and of the dominance of railroads. Now opportunities in this field have been reduced quite a bit. However, there are still lucrative positions open, such as property surveys, the U. S. Coast and Geodetic Survey, and various other federal, state, and municipal agencies that make surveys.

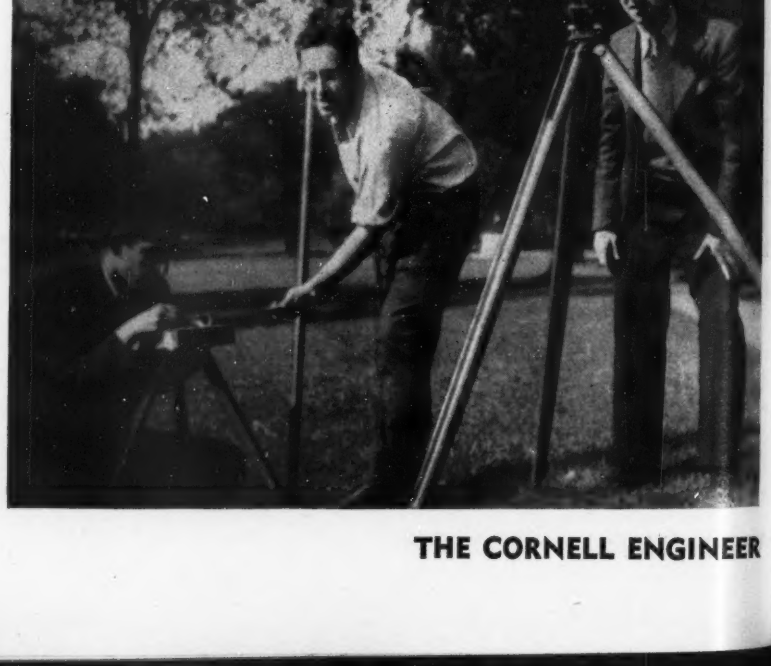
Elementary Course

Elementary Surveying 210 first gives the Civil Engineering freshman an idea of the principles of details of construction and use of the transit, Wye level, and dumpy level. In the classroom, the students learn how to test these instruments and how to adjust any minor variations; they also learn the coordinate method of computation of traverses. In the field they receive practice in the use of the steel tape, level, and transit, and learn fundamental surverying methods which include the measurements of lines, angles, differences of elevation, land surveying, areas, and plotting. At the end of the term a prescribed traverse is run on the library slope after which the students compute the area of the traverse from the field results. Then a map is made showing the accurate location of the points of the traverse and the location and plotting of buildings, roads and paths within or connected to the enclosed area. In the main, this course prepares for advanced surveying.

For ME's and EE's

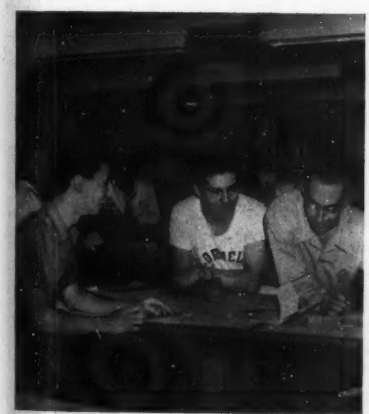
Elementary Surveying 210A is a one-hour course required of fresh-

Part of a precise taping party doing base line work for Summer Surveying. *—Reese*



men in mechanical and electrical engineering. At one time there was a common freshman year at Cornell for all engineers. At that time surveying was a part of the curriculum, and all took the course. Later, it was decided that this idea of a common year was not beneficial to the engineering courses as a whole. When the curricula were changed, the surveying requirements for the various engineering schools were changed with it. While the Civil Engineering surveying course was intensified, the ME's and EE's had the credit for their course reduced. Now they learn field work fundamentals with accent on the use of the steel tape, transit and level. Problems that are of particular interest to these branches of engineering are presented to the students. At some time a mechanical engineer might be required to run a line in a shaft, conduit, or fitting. Again he may be asked to find the accurate location of a specified machine. An Electrical Engineer might be asked to line in cables or wires. All these things and many more are best done by surveying methods, and a knowledge of these methods is certainly beneficial. During the war, certain parts in the manufacture of airplanes were lined up by surveying instruments handled by mechanical engineers.

Advanced Surveying 211 is a follow-through of course 210. It is usually given in the upper freshman term to Civil Engineering students. It lays a greater stress on the theoretical aspects of surveying than the practical. Introductions and studies of city and mining surveys, surveys of United States public lands, rectangular coordinate systems for cities and states, volumetric, topographic, hydrographic and geodetic surveying, transit, stadia and plane table surveys, sextant, soundings, triangulation, base lines, precise and trigonometric leveling, elements of photographic surveying and map projections are made. This is quite an intensive course as can be seen from the above imposing list. Most of the terms given are technical and have little meaning to parties not directly concerned with this type of work. In simpler language, the course endeavors to teach the student the different methods required for various types of jobs. City, mining, and public land surveying all have their individual techniques, requirements and pitfalls. The methods of plotting and locating reference lines across states, townships and cities are discussed as well as the various types of map projections and their meanings. Students learn the stadia method for quick and easy determinations of distances and elevations. They also learn how to use the plane table and so do their mapping in the field, directly on the job. The field work for the term is rounded off with a precise traverse of an order of accuracy that might be used for urban work.



—*Reese*

Mapping field notes in class.

—*Reese*

A precise levelling party on the campus.

Route Surveying

Route Surveying and Drawing 260B is partly a surveying course and is also connected with transportation engineering. It is more or less a substitute course given in lieu of Location Surveying 260A which is taken at the summer camp, discussed more fully below. "Route" is an upper sophomore Civil Engineering course. The recitations cover the theory of simple, transition and vertical curves and earthwork computations with applications to practical problems for purposes of illustration. For the earthwork computations, the late Prof. Crandall's unique "Earthwork Tables" is used. The simple and transitional curves referred to are highway and railroad curves of various types designed to make the easiest turning for the vehicle. A vertical curve is an easy transition from one grade of the road to another.

Field Periods

The field periods take up two-thirds of the term and are devoted to computing, laying out and checking these transitional curves. Each section is usually divided into parties of three or four so that the student receives more individual instruction, more practise in handling instruments and a more intimate knowledge of the problems than he would in larger parties. The drawing periods take up the remaining third of the term and in them the student makes a map of a preliminary line surveyed in course 260A and prepares a detailed "paper location" report based on these data. A profile of the final location (determined by the individual student) as to be run in the field is then re-

(*Continued on page 27*)

PROFILES

Of Outstanding Alumni

Prof. C. E O'Rourke, CE '17

C. E. O'ROURKE is one of those relatively few men who practice what they preach. Not only is he Professor of Structural Engineering at Cornell, but since 1932 he has maintained a private practice as a consulting engineer which has included the structural design of many steel, concrete, and timber buildings and bridges. Notable among these is the much publicized reinforced-concrete flight hanger for the Curtiss-Wright Co. of Buffalo, a continuous rigid-frame structure about 1000 feet long. One of the largest of its type in the country, this hanger contains over 180,000 square feet of floor area. O'Rourke is now working on the design of the approaches and foundations for a 250 foot double-leaf bascule bridge at Buffalo.

"Pat" O'Rourke, as he is usually called by his friends, has centered his life around civil engineering. He has that quality of "living" buildings and bridges which makes a truly great engineer. O'Rourke does have diversions however. He enjoys a good round of golf when he has the time, and holds a private flying license obtained with his son in Honolulu.

Born in New York City, O'Rourke graduated from Stuyvesant High School and planned to study engineering at New York University. However, the day before the competitive examination for Cornell tuition scholarships, O'Rourke was persuaded by a classmate to try the exam. With no preparation, but with a desire to see what a real examination looked like, he took the test and was later surprised to learn that he had won a scholarship. This cost NYU a prospective customer, gave Cornell another non-paying student, and won O'Rourke a lovely wife; for it was while attending Cornell that he met Miss Hilda Julia Mullen of Patton, Pa., a student in the Ithaca Conservatory of Music (now Ithaca College), whom he married in 1917.

Pat has two children, Patricia Ann, whose husband was cited in the battle for Okinawa, and Robert Edward, a First Lieutenant in the AAF, who has been awarded the Air Medal with 10 Oak Leaf Clusters, the DFC, and a Presidential Unit Citation.

While in school, Pat joined Sigma Phi Sigma fraternity and was elected to Chi Epsilon and Tau Beta Pi, honorary engineering societies. He is also a member of Pyramid and of Gargoyle, honorary architectural society.

Graduated in 1917 from the Cornell School of Civil Engineering, O'Rourke has been a member of the School's faculty since 1919 except for occasional leaves of absence. He became Assistant Professor in 1923 and Professor of Structural Engineering in 1934. In 1921 O'Rourke was Visiting Professor of Structural Engineering at the Carnegie Institute of Technology; and during the years 1926-27, he was in charge of the structural engineering department of the Imperial University at Tientsin, China. In 1941 he was Visiting Professor of Structural Engineering at the University of Hawaii, Honolulu.

In the years following his graduation, Pat has seen more than the classroom side of engineering, however. From 1920 to 1928, he was designer for the Concrete Steel Co. of New York City. It was in the design of the one and a quarter million dollar Thayer Hotel at West Point by this company that O'Rourke was placed somewhat "on the griddle."

To support a platform in the lobby he proposed to place a post under one corner to carry the load to a footing beneath the basement floor. Sometime later the architect frantically called O'Rourke and told him that the post came down in the center of one of his kitchen stoves. The confident young engineer asked, somewhat facetiously, if the architect was sure there were no main columns in the space reserved for the ash cans. When the architect explained the importance of the stove and the kitchen lay-out, however, Pat realized the value of efficient architectural design and altered the framing so as to eliminate the post, whereupon the architect agreed to move any objectionable ash cans.

Since 1937 O'Rourke has been consulting engineer for the cooperative Grange League Federation. In this position he has designed a large number of stores, warehouses, grain elevators, and freezer-locker plants in New York, New Jersey, and Pennsylvania. In 1938 he was a member of the Jury of Award for the $200,000 award program of the James F. Lincoln Arc Welding Foundation, and in 1944 he served on a special committee to formulate rules for the 1946 textbook award program.

O'Rourke has been engineering consultant for the American La-France-Foamite Corporation of Elmire, N. Y., since 1942, during which time he was in charge of a project involving the re-design of their 85 and 100 foot aerial ladders. He is now a consulting member of the Post War Planning Committee of this company.

Combining his practical experience with theoretical studies for the benefit of new students of civil engineering, O'Rourke is Consulting Editor of the Civil Engineering Series for the International Textbook Co. of Scranton, Pa. He is Editor-in-Chief of the "General Engineering Handbook" and is co-author of several books.

Prof. O'Rourke

Recent Developments In Engineering

Techni-Briefs

New Aircraft Engine

A NEW aircraft engine, rated at 200 horsepower, has been developed by the Research Division of the General Motors Corporation after extensive flight testing for six years, it has been announced by C. E. Wilson, president.

Designed for installation in private air cruisers of the future, the new engine is an outgrowth of studies started eight years ago—and subsequent war contracts—in connection with the development of military robot planes.

The new engine is a radial type having four cylinders and operates on the two-cycle principle. Its unique feature is that a supercharger blower is used to increase performance and power reserve for take-off and altitude. There are no valves, this function being performed by the pistons themselves. Although the piston displacement is only 250 cubic inches—the size of an automobile engine—it develops normally 200 horsepower with a high factor of safety, and the weight dry is only 275 pounds. It is probably the only small engine and may be installed for the same weight as an air-cooled engine. It is only 35 inches in diameter.

Oil consumption is extremely low, a quart of oil serving for six hours running. Fuel consumption is comparable to engines of similar power, about 13 gallons an hour using 91 octane fuel.

Television From Plane

YOUR television broadcasting station of tomorrow will be an airplane flying lazily in circles six miles above the ground and above the weather.

Originated by C. E. Nobles, and called Stratovision, the network of flying antennas will be inaugurated by Westinghouse just as soon as permits and equipment can be obtained. Programs from ground studios will be beamed to the cruising planes, then re-broadcast to television receivers in homes.

Because television and FM radio waves travel in straight lines, they do not follow the curvature of the earth but simply shoot off into space. This means that television broadcasts from the highest practical tower erected on the ground cannot be received much more than 50 miles away from the source. By raising the antenna and transmitter 30,000 feet into the air, the reach of the short waves is increased four times, thus drastically reducing the amount of equipment necessary to pick up and relay the programs. To provide coast-to-coast linkage by ground installation would require approximately 100 relay towers and hundreds of transmitters; or a 6000 mile co-axial cable network estimated to cost at least 100 million dollars.

Four planes, to be built by the Glenn L. Martin Company, will be assigned to each broadcast location, with two in the air at all times—one handling programs, the other standing by to take over in case of emergency. The planes will operate in eight hour shifts, but will be fueled to stay in the air a maximum of 13 hours. Relief planes will be sent aloft sufficiently in advance of shift changes to insure uninterrupted service.

Because of the great height of the antenna and transmitter, the broadcasts will be practically free from the interference and distortion caused by unwanted reflections from buildings, mountains, or other obstacles, and by the numerous amplifications necessary under previous ground-located systems.

Illustrating the range covered in television broadcast from airplane.

Hot Stuff

USING a thermocouple, A. H. Young of the General Electric Research Laboratory found that the lighted end of a cigarette is so hot its temperature is slightly above the melting point of aluminum or magnesium, between 1200 and 1325 degrees Fahrenheit.

Smokers don't get burned because fibrous materials containing air spaces, such as the tobacco in a cigarette, are inherently good insulators. Consequently, the temperature drops very rapidly from the hot end.

PROMINENT

Dick —*Reese*

Richard E. Goll, ME

ONE of the group to arrive from Penn State in July 1943 was Richard Eugene Goll, better known as Dick. Dick spent his first term of college as a civilian at State, but since being sent here by the navy has become a loyal Cornellian. Dick is a mechanical engineer but his interests are far broader than an academic study of engineering.

Unfortunately with the accelerated program Dick has not been able to get out during vacations and secure some practical working experience and generally enjoy life as would be his natural desire. Before he got down to the steady navy routine Dick spent his more frequent vacations and spare time in a variety of ways. Part of his time, he confesses, he spent simply trying to get a "glamour boy" tan at the seashore. But perhaps we can't blame him too much for this because he comes from the "city of brotherly love," Philadelphia, where everybody who is anybody goes to the shore for at least some time. All his time was not spent in idle amusement, for he drove a car as a chauffeur and worked in a Super Market as a cashier where he thinks he profited by meeting all types and sorts of people.

Dick has spent most of his spare working time on the *Cornell Engineer*. Dick came out as a compet in July 1944 and has rapidly advanced since then. Shortly after his election as a board member he was made associate editor and later became editor-in-chief. Dick's success on the Engineer can be traced not only to his ability to work with other people but also to the fact that he genuinely likes the work. He believes that he has gained much valuable experience in expressing

(*Continued on page* 24)

Joe Brozina, ME

"WELL," said Joe Brozina, settling back in his chair, "there isn't too much to my story." But knowing Joe, as does most everyone on the Hill, I waited confidently for the story which I knew would be good. Joe paused briefly, as if to think back into the past, and then began:

"About athletics— Well, I've been at it since I was a kid—went in for all kinds of sports. Did well in high school, winning five varsity letters in football and swimming.

"Came to Cornell and rowed in the frosh crew. Next to football, I think it's the greatest sport on the hill.

"This is my third year on the Varsity football team. Hope I don't get my legs in the wrong place this season—it gets sort of tiresome picking up the splinters.

"Think that Ed McKeever is a great coach and a great guy. The team should go places this year—wish I could finish the season and play in the Penn game. Believe there's a revival of that old Cornell spirit in the air.

"How I got into engineering? I was very interested in technical subjects but it was more of a matter-of-course. Always had a burning desire to follow a military career—nursed it along through high school right up to college. Enrolled at the Newark College of Engineering with intention of getting a year's college experience to prepare for the Naval Academy. Enlisted in the Naval Reserve in the V-1 program and ended up at Cornell in the V-12,—found I liked the place. Forgot about the Academy when an appointment fell through. Am too close to a degree and commission now.

"Like the Cornell way of life—the parties of course. Was initiated into Atmos and Pi Beta Tau—can find me at any of their parties matching the boys, mug for mug.

"Never will forget some of the fellows that I've met at Cornell—hope we will have many reunions in the future.

"Love to draw. Joined the 'Widow' staff last October. Hope to follow cartooning merely as a sidekick or hobby. Quite often gets you into trouble though. You draw people as they really are, but also how they hate to be. Am ardent admirer of Bill Mauldin. Think Barrow is the best political cartoonist.

"Believe that an engineer, like an artist, should develop an eye for beauty and appreciate a well-built body.

"The summer term was my last at Cornell—graduate this October with a B.M.E. My immediate future is in the hands of the Navy —hope to get on an oversized tin can.

"Am anxious to get into industry in a general field of engineering—haven't decided what to specialize in. Think the technical sciences have advanced much more rapidly than the social sciences and will be the big problem in the future."

To this, Joe's account of himself, I only have to add—no wonder, that Joe Brozina is a prominent engineer.

Joe

ENGINEERS

Horace R. Johnson, EE

"SCRE-E-E-ECH, bang," and Horace Richard Johnson pulls his motorcycle up in a cloud of dust, dismounts, and starts to take the infernal machine apart again. "Dick," or more commonly, plain "H. R.," is really getting to know his way around the insides of the thing despite the fact he is an EE and hence supposedly innocent of what exists inside a transmission housing.

Dick was born on April 26, 1926, in Jersey City.

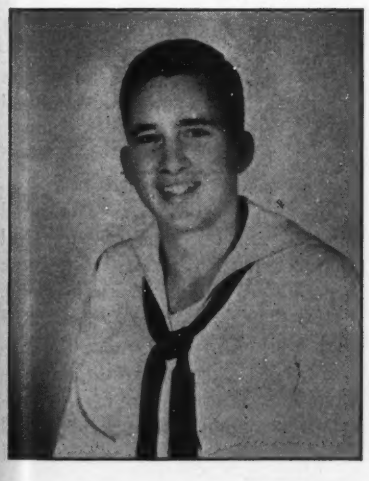
Just when "H. R." became interested in things scientific is not quite ascertainable. He first showed his leanings towards EE when as a child he "liked to stick a screwdriver in a light socket and watch the pretty sparks." However, Dick really gained recognition when, after moving to Teaneck, N. J., he got started in the high school there. He thinks this high school is one of the best and considers himself very lucky to have had a brilliant math teacher, Mr. Becker, while there. After hearing "H. R." describe the assembly program which he and another student presented on the subject of science and scientific magic, it would seem certain that Teaneck High School won't forget "H. R." either.

When asked why he picked Cornell, Dick pointed out the fact that his high school library subscribed to the *Cornell Engineer*. There Dick saw plans for Olin Hall, and since he had a leaning toward Chemical Engineering at the time, his mind was made up. However, when Dick did get here (well secured in the clutches of the Navy V-12) in the summer of '43, he chose Electrical Engineering from those courses offered by the Navy. He did this because he felt EE to be a more mathematical branch of engineering, as well as more abstract and mysterious—all qualities which are sure to arouse Dick's interest.

Dick hasn't been loafing around since then either, though if one did check up on the amount of time he studies such action might be in-

(*Continued on page 24*)

"H.R." —*Reese*



Theodore J. Bliss, EE

ON May 22, 1926, there occurred an event which was far-reaching in the engineering world: Theodore Jay Bliss, better known as Ted, first saw the light of day in Valley City, North Dakota. At an early age, inspired by a movie, he demonstrated to his father (an eminent civil engineer) how they "flew in the movie." This he accomplished by diving headfirst from the fourth step of the cellar stairs onto the concrete. Partially frustrated by this unfortunate incident, Ted turned to Scouting—and became an Eagle, the highest possible rank. After five summers at scout camp, the last as junior counselor, he spent a week in the Canadian woods just north of Duluth on a canoe trip. But during these winters he was busy too—he acted in a number of plays, worked as a grocery clerk and a lumberyard attendant, and later read water meters: "Truly a novel way of getting acquainted with everyone's basement." Apparently his formal education didn't suffer any from all this activity, since he was given the Bausch and Lomb award upon graduation.

When asked why he came to Cornell, he said, "I hardly knew where the school was, and I certainly never expected to come here until I got my orders from the Navy. But I'm sure glad I did." When asked why he chose to study electrical engineering, he said, "I just liked the thought of heavy power work with turbo-generators and so on. I didn't know it took so damn much arithmetic."

Ted —*Reese*

Ted is a well-known and well-liked man on the hill. On the scholastic side he is president of our chapter of Eta Kappa Nu and an initiate of Tau Beta Pi. He is a veteran crew letterman and a member of the crew club. He rowed at number two oar in the varsity race with Columbia this spring—in his own words, "Winning was indubitably my greatest thrill." Ted is a member of A.I.E.E. and Alpha Tau Omega, and has been working toward opening their house again. Besides this, he used to "dabble" in photography, "till my camera was hooked."

"T. J." plans to graduate with a B.E.E., power option, in February 1946. When he leaves the Navy, he plans to hold a job for a couple of years' experience. Following this, he may return to school, "Depending at what point I pick a wife up on." He's enjoyed his stay at Cornell, especially appreciating the lovely campus and surrounding countryside for its contrast with the flat spaces of North Dakota.

We may be sure that if Ted keeps up the good work like he has here at Cornell, he will be more than successful in his chosen field.

NEWS OF THE COLLEGE

Administration Building

Ground was broken on October 22 by George F. Rogalsky, university treasurer, for the new administration building. To be erected at the corner of Tower Road and East Avenue on the Cornell campus, the $700,000 structure will be constructed of buff limestone to harmonize with nearby buildings, and is scheduled for completion late in 1946.

Morrill Hall, which has served as the main administration building since 1868, will be used for departmental offices and for classrooms upon completion of the new structure.

Enrollment High

With more than 6700 enrolled in the various colleges and schools of the university, including those in New York City, Cornell's student body is near the all-time high enrollment of 1940.

Approximately 4200 of those enrolled are men. New students, most of whom are freshmen, total approximately 1800, including 1300 men and 500 women. Preliminary figures, which do not include the 1000 in Navy and Marine programs, indicate 900 students enrolled in the College of Engineering.

Dr. Gross Leaves

Dr. Eric T. B. Gross, formerly assistant professor of Electrical Engineering at Cornell, joined the staff of the Illinois Institute of Technology on Nov. 1. Dr. Gross is a graduate of the University of Vienna. He was instructor in Experimental Electrical Engineering at the Institute of Technology in Vienna. He later became Electrical Engineer in the Central Station Department of "A. E. G. Union Electric and Manufacturing Company" in Vienna, an affiliate of General Electric Company, where he was in charge of the division for protective devices and high voltage practice from 1929 to 1934, and in charge of the Department of Engineering from 1935 to 1938.

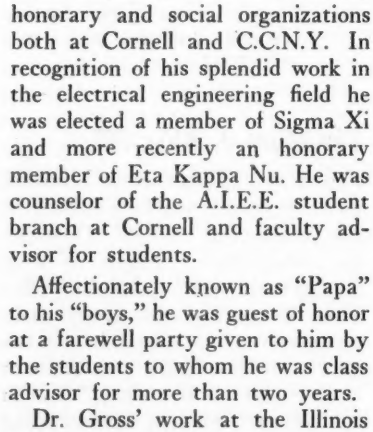
After coming to this country, prior to joining the staff at Cornell, he was an instructor at City College in New York. Dr. Gross is the author of many papers on relaying, lightning protection, ground fault neutralizers, and other phases of high voltage power engineering practice. In 1937, Dr. Gross was chairman of the section "System Protection and Grounding" at the International Conference of Large High Voltage Power Systems in Paris. He is a holder of fourteen patents concerning protective arrangements for electric systems.

Dr. Gross is a member of several honorary and social organizations both at Cornell and C.C.N.Y. In recognition of his splendid work in the electrical engineering field he was elected a member of Sigma Xi and more recently an honorary member of Eta Kappa Nu. He was counselor of the A.I.E.E. student branch at Cornell and faculty advisor for students.

Affectionately known as "Papa" to his "boys," he was guest of honor at a farewell party given to him by the students to whom he was class advisor for more than two years.

Dr. Gross' work at the Illinois Institute of Technology will be primarily on the graduate level in power system engineering.

Dr. Gross



Hollister's Address

Dean S. C. Hollister of Cornell University College of Engineering, addressing the fourth annual past president's dinner of the Engineering Society of Buffalo, Inc., at Hotel Lafayette, predicted that by 1949 the engineer shortage in all fields will reach 55,000. He asserted that while the other major allies have maintained a constant supply of technically trained men, "the United States will find these men will not be available when they are needed most."

The situation will be the same for a decade, according to Dean Hollister. However, so far as young men are concerned, the future in the engineering field "is particularly rosy."

Dean Hollister said it is "crystal clear" that the scientific advancement and industrial development in the postwar period "will be something we have never seen before." He urged engineers to co-operate with industry rather than compete with each other and called upon educators to widen their service to the community.

C. W. Terry has been promoted to associate professor of aeronautical engineering. A Cornell graduate, Professor Terry has instructed in the College of Engineering since 1926. He has been on leave since 1942 to carry on work in aeronautical design with Consolidated Aircraft and later as chief flight test engineer for Ryan Aeronautical Corp.

Fred W. Ocvirk was appointed assistant professor of aeronautical engineering in the new Graduate School of Aeronautical Engineering. Prof. Ocvirk became associated with Cornell in 1940 under the Engineering, Science, and Management War Training program in Buffalo, organizing and supervising all ESMWT courses in aeronautical engineering.

ALUMNI NEWS

DR. WILLIAM F. DURAND has returned to retirement at the age of 86. Professor emeritus of Stanford University and chairman of the division of engineering and industry of the National Research Council, Washington, D. C., he received the American Society of Mechanical Engineers Medal, July 28. The Society's highest award was in recognition of his work in hydrodynamic and aerodynamic science, particularly the forwarding of the design and application of jet propulsion principles, and of his services to the Government in engineering research. Dr. Durand was formerly professor of Marine Engineering and Director of Sibley College.

PROFESSOR JOHN R. BANGS, M.E. '21, Administrative Engineer and assistant track coach for many years, has resigned. He has been on leave for two years as director of industrial and personnel relations at the Edward G. Budd Manufacturing Co., Philadelphia, Pa.

JOHN F. MCMANUS, C.E. '36, for the last three years in charge of the University's engineering courses in the ESMWT program in Buffalo, where he is first vice-president of the Cornell Club, has been appointed acting assistant professor in Civil Engineering for the University's summer term.

MARTIN GOLAND, M.E. '40, has won the 1944 Spirit of St. Louis Junior Award. This award, established in 1938 by an endowment fund created by the General Committee for the 1935 Aeronautic Meeting in St. Louis, is made every three years for the best paper on an aeronautic subject presented by a junior member of the A.S.M.E.

Mr. Goland, head of applied mechanics section, structures department, at the Research Laboratory of the Curtiss-Wright Corporation, Buffalo, N. Y., presented a paper on "The Influence of the Shape and Rigidity of an Elastic Inclusion on the Transverse Flexure of Thin Plates," at the A.S.M.E. 1942 Annual Meeting, which was subsequently published in the Journal of Applied Mechanics in June, 1943.

After graduating from Cornell, he remained at the University for two years as instructor in mechanics of engineering before entering the employ of the Curtiss-Wright Corp. He has been a member of the staff of Engineering, Science, and Management War Training in Buffalo for two semesters.

NORMAN R. Miller, M.E. '24, application engineer for the past two years at San Francisco for the Marine Division, Westinghouse Electric and Manufacturing Co., has been transferred to Los Angeles, Cal., to fill a similar post. In his new position, according to Mr. Walter G. Willson, Los Angeles Westinghouse manager, Mr. Miller will represent Westinghouse, a major electrical supplier to the marine industry, at the numerous shipyards and marine centers throughout the Los Angeles area.

Mr. Miller became associated with Westinghouse at East Pittsburgh, Pa., as a graduate student, and later became an application engineer for the company's Generator Division there. He joined the company's Industry Sales Division at East Pittsburgh in 1937, and in 1943 was transferred to San Francisco as an application engineer for the Marine Division, a post he held until his transfer to Los Angeles.

Mr. Miller

JOHN L. Collyer, M.E. '17, president of B. F. Goodrich Co., Akron, was re-elected as Alumni Trustee for a five-year term beginning July 1.

CAPT. WILLIAM B. VAN ORMAN, M.E., '37, *designed and installed a new system to speed engine repair at the Rome Air Technical Service Command depot. The automatic conveyor belt system speeds cleaning of parts disassembled from engines undergoing repair, eliminating a serious bottleneck in the rebuilding of aircraft engines. Previous to his enlistment he was employed as research engineer at the General Cable Company.*

MAXWELL M. Upson, M.E. '99, was re-elected to the Alumni Board of Trustees for a five-year term beginning July 1. Mr. Upson, president of Raymond Concrete Pile Co., New York City, was first elected an alumni trustee in June, 1925, and has served continuously since.

DR. Nickolas Kulik, M.E., is now chief engineer of the B-H Aircraft Company, Inc., Long Island City. A McMullen graduate scholar in the School of Mechanical Engineering, he later received his Ph.D. at Purdue University.

The B-H Aircraft Co., for which Dr. Kulik is chief engineer, has been engaged in the manufacture of aircraft auxiliary equipment for both the Army and Navy during the war. At the present time they are also making jet propulsion equipment. In his new position, Dr. Kulik will be responsible for engineering and developing equipment of this kind.

ROBINSON Airlines has ordered two all-metal, twin-engined, eight-passenger transports for its Ithaca-New York City flights, and for a proposed Ithaca-Washington route; Cecil S. Robinson, '21, president of the company, expects delivery in the fall.

Cornell Society of Engineers

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

Mr. Leinroth

President's Message

THIS year the Society intends to intensify its efforts toward increasing its membership. While we have had an encouraging growth in members over the past few years yet too small a percentage of the graduates of the College of Engineering are enrolled in the Society. We need to increase our membership.

We are not going to endeavor to increase the membership because we want to take pride in large numbers; we are going out to increase our membership because we feel that the Society is a real force in bringing the alumni and the College closer together and we look upon this as our most important function. We believe that the welfare of the College and its graduates will, as a natural result of this closer tie in, be enhanced with increased Society membership.

It is almost needless to point out the importance of a closer tie in between the alumni and the College. That a closer tie will be beneficial should be obvious to all; it is especially important at this time when we are on the threshold of such great developments in the College and when the support of all is needed. It is not too much to say that the success of the plans for the College will be almost in direct proportion to alumni interest and support. Certainly the plans cannot be put through without strong alumni support.

To get effective support from the alumni they must be made to take a real interest and pride in the College. And for them to take such interest and pride in the College it is necessary that they have intimate knowledge of its past contributions, what it is now doing, and its future plans.

Relatively few alumni realize the extent of the contributions that the College of Engineering, its faculty and graduates have made. They have been made in many fields and in many countries; the College of Engineering at Cornell yields to no other in the eminence and the number of its graduates in high positions. Faculty, alumni and undergraduates all have reason to swell with pride at these accomplishments but do we know as much about them, appreciate them and cherish them as we should?

The well thought out plans for the development of the College have aroused the enthusiasm of all who have had them presented to them. It is the job of all of us to see that more alumni enthusiasm is aroused through more knowledge of these plans and to add our bit to bringing them to an early fruition.

The Philadelphia Chapter of the Society has had these points in mind in planning their program for this year. Through monthly meetings they have set out to gain the support and interest of Philadelphia alumni by informing them of what the College is doing and what its plans are. Outstanding alumni and faculty members will address these meetings. Dean Hollister will take the story to other meetings throughout the country. It is hoped that these talks will be made available to the Cornell Engineer for publication so that all of us may read them.

It is important, too, that the undergraduates be made acquainted with the aims and activities of the Society. Plans for enrolling more of them as members on graduation are under consideration now about which we hope to have something of interest to report in the near future. It is most desirable that recent graduates keep their interest in the College which so often wanes when they leave the campus and we feel that through the medium of the Society we can help them maintain their contact with the College. With many coming back after being in the armed forces, this matter of enrolling young graduates into our membership takes on an added significance.

All of this is going to be the job of all members of the Society—not just the job of the officers. You can help by learning and passing on to others the accomplishments, activities and plans of the College, by attracting new members and by entering into the activities of the Society.

J. PAUL LEINROTH '12

Making a **MIDGET**

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NO bigger than a five-grain aspirin tablet —that's the size of a new non-linear coil, specially designed so that an FM transmitter and receiver might fit into the cramped interior of a tank!

This mighty midget that does the work of *four vacuum tubes* and *two tuned circuits* was developed by Bell Telephone Laboratories—and constituted a real challenge to the manufacturing engineers of Western Electric. Besides being the smallest toroidal coil ever produced for electronic equipment, the materials used were of the most delicate.

The core of the tiny doughnut-shaped coil consists of a small ceramic form wound with permalloy tape 3/32nds of an inch wide and in thickness about 1/20th the diameter of a human hair. The problem was how to wind 1/50th of a gram of this fragile tape around each core, and then to wind fine wire around the taped form.

Western Electric engineers discovered that a standard coil winding machine could be adapted for wrapping the foil-like tape around the form. However, when it came to applying the required forty turns of wire, they found that the only effective method was to have the wire *sewn by hand* around the minute core through the hole in the center . . . in much the same way that a seamstress sews around a buttonhole!

This system efficiently met military production demands—to the tune of over 100,000 units. It was just one of many far-reaching, interesting assignments mastered by radio, electrical, mechanical and industrial engineers at Western Electric. Now these combined production skills are once more dedicated to Western Electric's 63 year old job as supply unit of the Bell Telephone System.

Buy Victory Bonds—and keep them!

Western Electric

SOURCE OF SUPPLY FOR THE BELL TELEPHONE SYSTEM

Dick Goll

(*Continued from page* 18)

himself, in meeting and handling people, and in just being able to show something for the work done. "It also helps me," he says, "to see the engineering field as a whole and allows me to make a wiser choice of my own particular field."

Dick's activities while at Cornell, however, have not been entirely confined to academic work and to the *Cornell Engineer*. He joined Phi Kappa Psi at State and transferred to the Cornell chapter. He is a member of Mesne, A. S. M. E., and is vice president of Atmos, the honorary mechanical engineers' society. Aside from his participation in these organized activities Dick says he "likes to wander around the hills and pathways of the campus thinking and mentally relaxing; likes swimming in the gorges, steaks, sunbaths, pipes, and real friends."

Dick's future plans will be decided by the Navy for awhile. Dick left Cornell at the end of October and he is now an ensign in the Navy, but with his success at college he should have no worry as to the future either in or out of the Navy.

"H. R." Johnson

(*Continued from page* 19)

ferred. Regardless, "H. R." is now president of Tau Beta Pi and is a member of Eta Kappa Nu. But don't peg him for a lifeless "brain." Any man who can stand near the top in the ranks of the Delta Club and actively help keep up the record of the Pi Beta Tau party boys is no "party-pooper." He did manage to squeeze in a summer season on the crew squad, but since then he has confined his athletics to PT. Dick is also chairman of the EE school honor committee, and has spent a term working during his spare moments for the Office of Scientific Research and Development in Rockefeller Hall. Says Dick about this experience, "I didn't do anything, but I sure learned a hell of a lot."

Dick's hobbies are centered about his aforementioned motorcycle and amateur radio. He intends to operate his own "ham" station if the Navy will "rescind its outdated order against personnel operating them," to use his own words.

"H. R." will receive his BEE (Communication Option) in February of next year, and then he plans to set in effect the H. R. Johnson Reconversion Program which has the following points: 1. "I will get out of the Navy as soon as I can"; 2. "I will buy a new motorcycle"; and 3. "I will hit either Cornell or Harvard for post-grad courses in physics."

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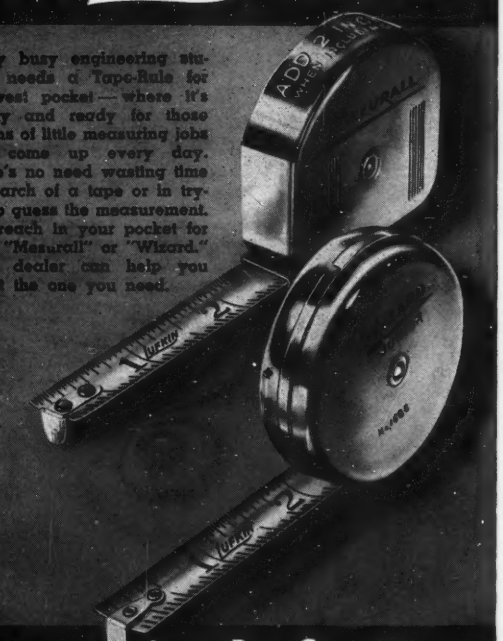

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Surveying Labs

(*Continued from page* 15)

quired along with a computation of the earthwork (i.e. "cut" and "fill").

Before the emergency period, Civil Engineering students would spend the summer following their sophomore year in surveying camp. Here they would gain most of their practical experience in the use of the various surveying instruments. The three-term-a-year system precluded the possibility of such a camp during the war and a new course had to be substituted for it. Summer surveying 231-A is the name of the wartime substitute. Working under obvious difficulties and drawbacks, the department has, nevertheless, produced a course that has come just as close to summer camp work as to experience, as possible. About half the term is spent on a traverse. Buildings and paths are located as in previous terms but this course goes further. Topography (contour lines and natural objects such as trees, etc.) is taken, computed in the field and plotted on the map. The rest of the term is spent in the use of instruments learned of in Advanced Surveying but not used previously by the student. Examples of this are the direction and repeating instruments which are very precise in the measuring of angles. A precise level line is run as well as the performance of some base line measurement. It has been said that more practical knowledge is gained in this one course than in all the rest of the surveying taken by C.E. students. The class is divided into equal parties, and captains are chosen on the basis of work done in previous surveying courses.

Base line measurment over a short distance. —*Reese*

The above-mentioned courses are all required. Beside these, the department offers various elective courses, foremost among which is Photographic and Aerial Surveying 219. This subject is supposed to give a general idea of what the field is like. It contains a study of the principles involved and their application to map-making and photographs. A study is made of the taking of the pictures and their subsequent examination. The transfer of data from photographs to small-scale, general purpose maps is reviewed and discussed. Three dimensional viewing of photographs (stereoscopic methods) and its application to map making and the Multiplex Projection for the manufacture of contour maps are also part of the curriculum.

The surveying courses given by the School of Civil Engineering are not primarily designed to train specialists, but to give the students a knowledge of surveying that will be sufficient as a solid background for ordinary practice.

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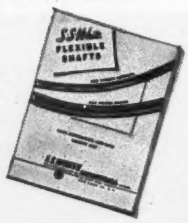

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Air Liners

(*Continued from page* 10)

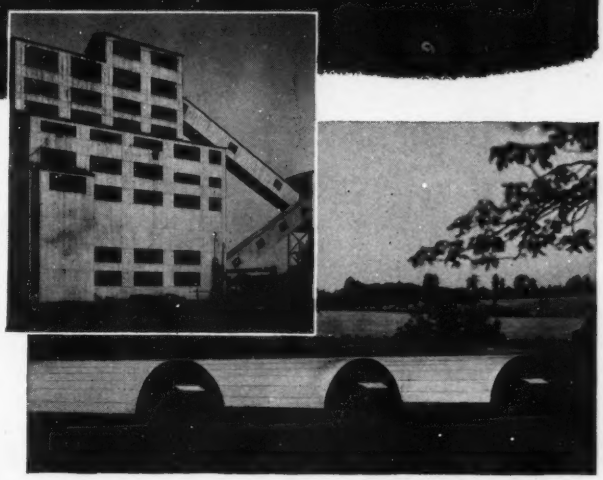
volved problems of visible exhaust flame and noise. More recent developments, however, have indicated that these objections can be overcome and that this simple and direct means of thrust augmentation can be applied with substantial efficiency benefits and, if properly applied, with marked improvements in aircooled engine cooling efficiency. A further possible development in the recovery of exhaust energy may be in the direction of turbine operation by the relatively low pressure exhaust gases delivering mechanical energy back into the propeller drive. The exhaust from this turbine might easily be conceived to generate some additional thrust by jet action. It is not difficult to visualize the possible transition from the reciprocating engine with its waste exhaust, through combinations of the reciprocating engine with exhaust jet thrust, and the reciprocating engine with exhaust turbine and jet thrust, through the gas turbine with jet exhaust, to the full jet thrust turbine-compressor unit without propeller. That, however, is visualizing a long range power plant revolution which will require an indeterminate time for accomplishment.

Increasing Complexity

There is one characteristic of modern aircraft which is distressing. This truly wonderful mechanism has by refinement and addition solved more and more of the many problems which the controlled use of the third dimension has introduced. However, it has not solved many of these problems without accompanying complexity. I would consider well justified in the organization of any manufacturer's engineering department, a group which would criticize every detail design with one question in mind, namely, can this job be done more simply? It is a matter of major concern to the operators that the effective hours of utilization and frequency of interrupted and delayed flights may be adversely affected by the increasing complexity of modern transport aircraft.

(*Continued on page* 30)

It's the ZINC *that Stops the Rust!*



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Air Liners

(*Continued from page* 28)

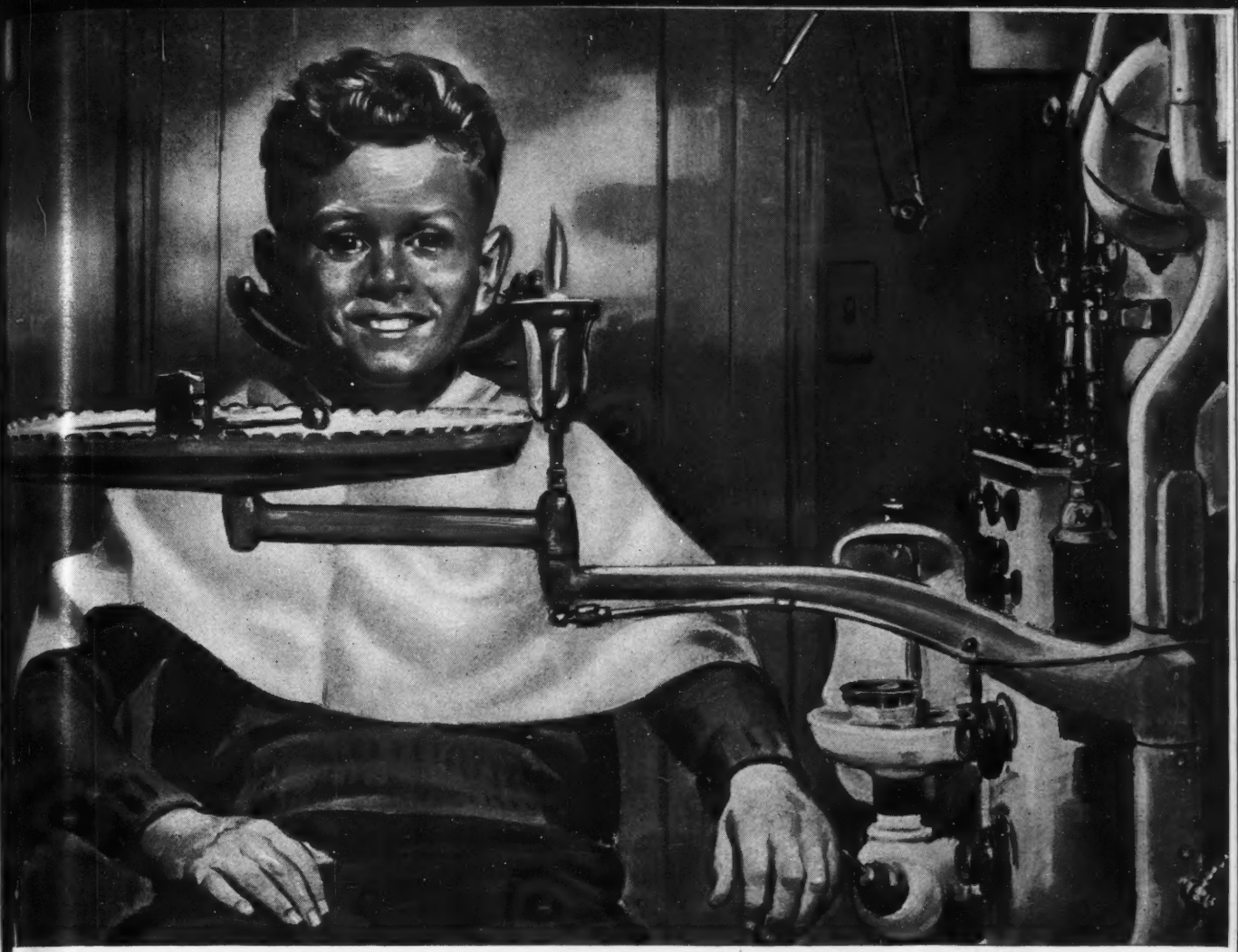
I must emphasize a few much needed refinements to the modern transport airplane. First among these I would list a substantial further reduction of noise and vibration. This should be tackled primarily by control of the source of noise or vibration. The introduction of cabin pressurization has also emphasized the need for adequate automatic air conditioning control, both heating and cooling, and adequate ventilating control over a wide range of external conditions. Ground air conditioning provisions must not be neglected. Humidity control has also come to the front as a requisite for pressurized cabins. Cabin, cockpit, and cargo compartment lighting has been an oft neglected item.

To repeat, we wish as few types of transport aircraft as possible to cover the field of varying transport requirements. Let me briefly list some of the possible characteristics of a series of such airplanes.

1. There may well be a small passenger airplane of 15 to 20 passenger capacity capable of carrying, for short range operations, its maximum passengers with a few hundred pounds of cargo. This would probably be a twin engine airplane capable of operating in and out of fields with minimum length runways. It would be intended for low traffic density operation in the United States and miscellaneous operations throughout other parts of the world where competing transportation is very inadequate. The cost of operation would undoubtedly be high, too high to be self-sustaining in a competitive American market.

2. There will surely be an airplane which might be considered a replacement for the DC-3 21-passenger airplane in the operation for which that airplane has been best suited, namely, 300 to 500 mile range. This would be an airplane capable of carrying approximately 30 passengers with available capacity to also handle a thousand pounds of cargo. It would probably be a two engine airplane substan-

(*Continued on page* 32)



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Air Liners

(*Continued from page* 30)

tially faster and more economical per passenger mile than the DC-3 and would be capable of operating from the airports of medium and small sized communities.

3. The airplane which would handle the top range of past DC-3 performances and might well extend that range as far as transcontienental non-stop operation, would be a four engine, high speed, medium high altitude, pressurized airplane of approximately double the DC-3 load capacity. There are two such airplanes actively under development to be available in the early postwar period. Such aircraft will cruise at approximately 300 mph and will operate at altitudes up to 20,000 ft. or more and, as stated above, at ranges up to 3,000 miles. Obviously such aircraft can be applied to over-ocean operation with suitable loads and overseas accommodations. Such airplanes can be designed with all types of interiors, from luxury sleepers to high density day planes, with suitable recognition of the effects of such loading on range, capacity, and type of service.

4. Although the airplanes mentioned in (3) can be used for long range over-ocean and transcontinental operation, the necessary reserves for such operation indicate that a larger unit would more comfortably and efficiently accommodate the longer ranges. There is needed for such uses airplanes in the 125,000 to 200,000 gross weight class. Some versions of these may carry smaller loads at extremely high speeds and others can accommodate much greater loads at slower speeds, depending on the traffic needs of the route and service.

5. If there is to be the hoped for development of air cargo, there will undoubtedly be needed within the required stated period at least one airplane designed expressly for the handling of air freight. Air cargo is cutting its teeth with aircraft now available and there is no reason why its possibilities cannot be developed and proven with some economic penalty with types of aircraft now applied to military cargo transport.

There is a real need in air transportation for a vehicle which will do the things which are characteristic of the helicopter. Miscellaneous, local passenger operations without elaborate airport provisions, such as air taxis serving airports and communities, would fill a real need. Whether or not the helicopter will fill that need remains to be seen. It must first find answers to an impressive list of technical plane and operation shows real problems. The pick-up type of air-promise for limited cargo and mail service to meet isolated small community requirements.

It is increasingly clear that within the next 5 years transport airplanes will be operating on schedule at speeds up to 400 mph. Think what that will mean in shrinking the size of the world and of these United States! Thirty hours from anywhere to anywhere on the face of the globe. Leave New York at 8:00 A.M. and start the business day in Chicago at 9:00 A.M.. And where we go after that, only the future can tell!

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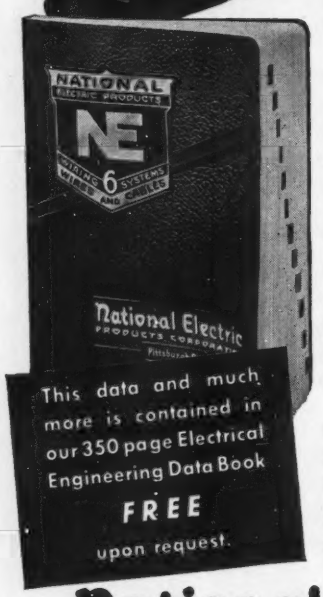

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Liquid Air Industry

(*Continued from page* 13)

ternally by liquid air; the charcoal adsorbs the gases producing a vacuum.

Most of the liquid air produced goes directly into the production of oxygen. The chief source of commercial oxygen today is liquid air. Enormous quantities of oxygen are used in the welding and cutting of metals by oxy-acetylene and oxy-hydrogen torches. Thus the production of liquid air has indirectly a large influence on the production of motor vehicles, ships, and other machines of war and peace. Large pieces of steel scrap may be cut down to convenient sizes for remelting by such torches. Oxygen is also used in the manufacture of varnish and in medicine for inhalation in cases of pneumonia or heart disease. Oxygen in the liquid form has also become of great use. By storing oxygen in the form of the liquid for use by pilots of aircraft at high altitudes, a large amount of space and weight is saved. Cartridges made of combustible substances saturated with liquid oxygen are powerful explosives. These are often used in mining; certain disadvantages arise, however, because of dangerous products of combustion and high inflammability. In World War One, as in the present war, Germany, because of a shortage of other explosives, used liquid oxygen explosives to some extent.

Liquid air has also found much use in the production of nitrogen. Nitrogen in turn is used for the manufacture of cyanides, cyanamide, and ammonia. The commercial preparations of fertilizers, explosives, and dyes depend much on nitrogen produced from liquid air. A plant producing nitrogen from liquid air, located at Muscle Shoals, Alabama, has a capacity of fifteen million cubic feet of nitrogen a day.

The recovery of the rare gases from the atmosphere by using liquid air has also increased the possibilities of the industry. By tapping off gases or liquids at proper places in the Claude system, argon, neon, helium, krypton, and xenon may be isolated. Argon and neon find great use in incandescent filament lamps and in lights of the gas-discharge type, respectively. It is said that lamps containing krypton and xenon are more efficient than those containing argon; the substitution of these gases for argon in incandescent lamps would increase the scale of liquid air production tremendously.

The extent to which the liquid air industry has grown in the course of some fifty years may best be seen from the figures available for the industrial production of oxygen. The first Linde plant for the production of liquid air was built in 1895. In 1907, the first plant in the United States of such nature for the production of oxygen was built. Its output was about 24,000,000 cubic feet of oxygen annually. By 1915, fifty liquid air-oxygen plants were in operation in Europe, while the total in the United States at this time was five. Later, in 1926, it was estimated that there were 281 plants in Europe producing oxygen from liquid air. In the United States today, there are over fifty large plants producing approximately 55,000 tons (1,360,000,000 cubic feet) of oxygen annually. These plants are situated in every industrial part of the country and produce more oxygen than was produced in the whole world prior to a few years ago. This rapid growth of the industry is the result of these new developments and uses for liquid air and its products.

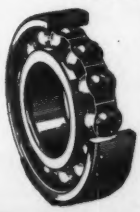
Nothing Rolls Like a Ball . . .

. . . and it looks as if the hungry gentleman above just can't digest that fundamental fact.

But, the fact that "nothing rolls like a ball" *has* been digested by machine designers. The simplicity of the *ball* bearing—which carries the loads on free-rolling, tough steel balls—is the answer to many a 64-*Million* Dollar Question.

Higher speeds, heavier load capacities, greater rigidity—in literally millions of applications—conclusively demonstrate the unique fitness of New Department Ball Bearings for the new scheme of things mechanical.

We believe no other bearing has as many advantages as the *ball* bearing. Particularly the ball bearing backed by the technical skill, long experience and meticulous manufacturing methods of New Departure.



There is more for you in New Departure Ball Bearings than steel and precision. Advanced engineering and a desire to serve are tangible plus values.

NEW DEPARTURE
BALL BEARINGS

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STRESS and STRAIN...

This column is dedicated to Phillip.

* * * * *

Willie: Say Pop, did you go to Sunday School when you were a boy?

Father: Yes, son, regularly. Never missed a Sunday.

Willie: Well, I'll bet it won't do me any good either.

The wonderful love of a beautiful maid,
The love of a staunch true maid,
Have existed since life began.
But the greatest love—the love of loves
Even greater than that of a mother,
Is the tender, passionate, infinite love
Of one drunken bum for another.

He: Why do the most important men on the campus always get the prettiest girls?

She: Oh, you conceited thing!

Intuition: A woman's ability to read between men's lyings.

Veteran of the Aleutians: While in the Aleutians I saw the screwiest bird. It lays square eggs and talks!

USO Commando: Oh, yeah! What does it say?

Veteran: Ouch.

A youth spends the years between 12 and 21 waiting to become his own boss—then he gets married!

Papa: "Stop reaching across the table Junior! Haven't you got a tongue?"

Son: "Yes, sir, but my arm is longer."

She: "Thanks for the kiss."

He: "Oh, the pleasure was all mine."

V-12: Why the crepe on the door, some one dead?

Another V-12: No, that's my roommate's towel.

Jean: You know Marty proposed to me last night.

Jane: Doesn't he do it beautifully?

He: I'm burning with love for you.

She: Oh, don't make a fuel of yourself.

WON'T YOU JOIN ME IN A GLASS OF BEER?

A lunatic was trying to knock a nail into a wall, but he had the head of the nail against the wood and was hammering at the point.

At length he threw down the nail in disgust and said, "Bah! Idiots. They gave me a nail with the head at the wrong end."

Another inmate who was watching began to laugh. "It's you that's the idiot," he said as he jerked his thumb towards the opposite wall. "Nail was made for the other side of the room."

* * * * *

Phillip who?

* * * * *

THE 23RD PSALM OF ETC.

Verily, I say unto you, marry not an engineer.
For an engineer is a strange being, and is possessed of many evils,
Yea, he speaketh eternally in parables, which he calleth formulae,
And he wieldeth a big stick which he calleth a slide rule.
And he hath only one Bible, a handbook.
He thinketh only of stresses and strains, and without end of thermodynamics.
He showeth always a serious aspect and seemeth not to know how to smile,
And he picketh his seat in a car by the springs therein and not by the damsels.
Neither does he know a waterfall except by its horsepower, nor a sunset
Except that he must turn on the lights, nor a damsel except by her live weight.
Always he carrieth his books with him, and he entertaineth his sweetheart with steam tables.
Verily, though his damsel expecteth chocolates when he calleth,
She openeth the package to disclose samples of iron ore.
Yea, he holdeth her hand but to measure the friction thereof.
And he kisseth her only to test the viscosity of her lips,
For in his eyes there shineth a far-away look that is neither
Love nor longing—rather a vain attempt to recall a formula.
There is but one key to his heart and that a Tau Beta Pi key;
When his damsel writeth of love and signeth with crosses, he
Taketh these symbols, not for kisses, but rather
For unknown quantities.
As a boy he pulleth a girl's hair to test its elasticity,
But as a man he discovereth different devices;
For he counteth the vibrations of her heart-strings and
He seeketh ever to pursue his scientific investigations.
Even his own heart flutterings he counteth as a vision of beauty,
And enscribeth his passion as a formula,
And his marriage is as a simultaneous equation involving two
Unknowns and yielding diverse results.
Verily, I say unto you, marry not an engineer.

* * * * *

Why, Phillip Space, of course.